



## A decade of publications on the use of handheld computers in healthcare

Uma década de publicações sobre a utilização dos computadores de mão em saúde

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**Descritores:** Computador de mão, Assistente Pessoal Digital-PDA 3, Paper Review

### ABSTRACT

The purpose of this study was to review articles published in PubMed between 1996 and 2007 that made reference to PDA (personal digital assistant) use in health care, and to classify these articles based on topics addressed and analyze their progress over an 11-year period. Of 1,375 publications initially found, 702 were excluded because they had no abstract (required for classification purposes) or showed biased inclusion criteria (articles not related to the topic of study were reviewed). A total of 673 articles were selected and then arranged by year of publication and classified into five groups according to the topic: Applications, Data Bases, Data Collection, Review, and Usability. It was concluded that the use of these devices in health care increased the number of publications. Most of them (40.1%) addressed PDA applications and only 19 (2.8%) were literature review of articles that had been published. This is the first study to show a potential trend in the issues addressed in these publications with a decrease in the number of articles focusing on PDA usability and an increasing number of articles that describe the use of specific PDA applications. This review study points to a wide range of possibilities for medical informatics professionals to develop useful applications.

### RESUMO

O objetivo deste estudo foi o de investigar os artigos publicados no PubMed entre 1996 e 2007, que fizeram referência ao PDA - Personal Digital Assistant - usado em cuidados de saúde e para classificar estes artigos de acordo com os temas abordados e avaliar a sua evolução durante o período de 11 anos. Das 1.375 publicações inicialmente encontradas, 702 foram eliminadas por eles não incluírem um resumo (que impedem a classificação), ou porque continham tendenciosos critérios de inclusão (artigos não relacionados com o tema do presente estudo). Um total de 673 artigos foram selecionados e estavam distribuídos por ano de publicação e classificados em cinco grupos de acordo com o tema: aplicativos, base de dados, bases de coleta, revisão e usabilidade. O estudo concluiu que o uso desses dispositivos na área de saúde causou um aumento no número de publicações. A maioria dos quais (40,1%), tratam de aplicações PDA e apenas 19 (2,8%) foram de revisão da literatura que já haviam sido publicadas. Além disso, este estudo é o primeiro a mostrar uma tendência possível nas questões de tais publicações, com uma diminuição no número de artigos que se referem à usabilidade e um aumento no número de artigos que descrevem o uso de aplicações PDA específicas. Este artigo de revisão indica que há uma grande gama de possibilidades para profissionais de informática médica para desenvolver aplicações úteis.

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## INTRODUÇÃO

The central objective of this survey is to investigate literature seeking indices and trends on the quantity and approach of papers dealing with PDA use by healthcare professionals. As such, the study used as a basis the PubMed service of the US National Library of Medicine between 1996 (when the first reference to the topic is found) and 2007.

*“An invasion of our lives by technology is inevitable...Several researchers have examined doctors’ information needs during patient care in different environments...”<sup>(1)</sup>.*

This trend notwithstanding, some situations complicate or hinder access to such information. There are a great many opportunities to blend the healthcare professional’s need to store and retrieve information with the various devices and resources that information technology makes available.

The Internet has contributed considerably to allowing the accessing of healthcare information and data bases worldwide through simple use of a computer and modem. Even so, there are situations where it is impossible to “take” all available technology close to those who need it – be it due to the high cost that this would entail, or to the lack of an appropriate infrastructure.

A practical example of this assertion is the medical care log next to hospital beds<sup>(2-4)</sup>. The information written by healthcare professionals (doctors, nurses, physical therapists, etc.) must be transcribed to some central computing system. Another situation unfavorable to the storage of information compiled directly into a hospital or clinic computer system involves home care or data collection in the field for research purposes<sup>(5)</sup>.

On the other hand, computer engineering (hardware and software) has already produced units (equipped with a processor, screen, memory, connectivity, etc.) with structural characteristics that are appropriate for use in the aforementioned situations - the Personal Digital Assistant, hereinafter cited as PDA. According to Fisher

(2003), “Since the introduction of handheld computers or personal digital assistants (PDAs) in the early 1990s, they have become increasingly popular for a variety of medical applications”<sup>(6)</sup>. Although Kuziemsky (2005) does caution that “there are very few studies that provide evidence-based results about impacts of such adoption and use”<sup>(7)</sup>. Subsequently, Wu (2006) also concluded that “Further study is required to determine the benefits with handheld electronic medical records”<sup>(8)</sup>.

This study investigates the evolution of the publication of articles referring to the use of such devices in the healthcare arena over the past 11 years insofar as the quantity and the focus given to said devices are concerned.

## METHODS

Firstly, the MeSH (Medical Subject Headings)<sup>(9)</sup> Internet site was searched to obtain the most appropriate research tags, with the following results: Computers, Handheld, PDA / Personal Digital Assistant, Palm / Pocket.

These terms point to the “*Computers, Handheld*” MeSH Heading, whose login page is shown as Table 1. The heading was found as a synonym to the “*Personal Digital Assistant – PDA*” term.

A preliminary search was conducted on the “*PubMed*” site using the descriptor “handheld” and the “*PDA*” synonym<sup>(10)</sup>. This same search was conducted using the “*Reference Manager*” software – whose objective is to manage a data base of bibliographical references. Since “*Reference Manager*” allows for searches on “*PubMed*” using the same criteria from the site itself in addition to importing references to a bibliographic listing using the “*Vancouver*” Style, this research tool was selected.

To guarantee that the results would fall within the desired context, associations with other terms had to be created. The terms “*computers*” and “*computer*” appear in different articles – which led to a different linkage for both descriptors. As a result, initial search criteria for articles on “*PubMed*” were:

**Publication date: 1996 – 2007**

(handheld AND PDA) OR(handheld AND computers)

**Table 1** – Login sheet for “Handheld” term on MeSH

<b>MeSH Heading</b>	Computers, Handheld
<b>Tree Number</b>	L01.224.230.260.550.500
<b>Scope Note</b>	MICROCOMPUTERS, sometimes called PDA, that are very small and portable, fitting in a hand, and that have much more function than a calculator. They are convenient to use in clinical and other field situations for quick data management. They usually require docking with MICROCOMPUTERS for updates.
<b>Entry Term</b>	Computers, Palm-Top
<b>Entry Term</b>	Computers, Palmtop
<b>Entry Term</b>	Palm Pilot
<b>Entry Term</b>	PDA Computer
<b>Entry Term</b>	Personal Digital Assistant
<b>Entry Term</b>	Pocket PC
<b>Allowable Qualifiers</b>	CL EC ES HI LJ SD SN ST TD UT
<b>Previous Indexing</b>	Microcomputers (1992-2002)
<b>History Note</b>	2003
<b>Date of Entry</b>	20020703
<b>Unique ID</b>	D034201

OR(handheld AND computer) OR(PDA AND computers) OR(PDA AND computer)

**Table 2** –PubMed Search Criteria

<p><b>Publication date: 1996 – 2007</b>          (handheld AND PDA) OR          (handheld AND computers) OR          (handheld AND computer) OR          (PDA AND computers) OR          (PDA AND computer)</p>
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The above criteria yielded a total of 1,375 publications. Even with the precautions taken to gather the relevant articles, there were some unexpected results because some descriptors were used in other contexts. For example:

- Handheld: Handheld dynamometer, Handheld pupillometer, Handheld gamma probe counter, Handheld light source, Handheld instruments, Handheld myometer, Handheld mamotome, etc.

- PDA: Polydiacetylene, Patent Ductus Arteriosus, Panic Disorder with Agoraphobia, Posterior Descending Artery, Power Doppler Angiograph, Prototype Digital Archive, Pixel Distribution Analysis, etc.

For this reason, another selection criterion was added for the articles: having an abstract, which allow for better verification of the previously gathered publications (1,375). Other authors who surveyed the literature such as Fox (2007)<sup>(11)</sup> and Garritty (2006)<sup>(12)</sup> used this same tool. After adding these second selection criteria, 437 articles were eliminated, leaving a list of 938 articles on PDAs in healthcare between 1997 and 2007. It is highly probable that the remaining number of articles would have been higher if all of them had been included in abstracts (e.g. “Compute ‘n carry:

transporting patient information”).

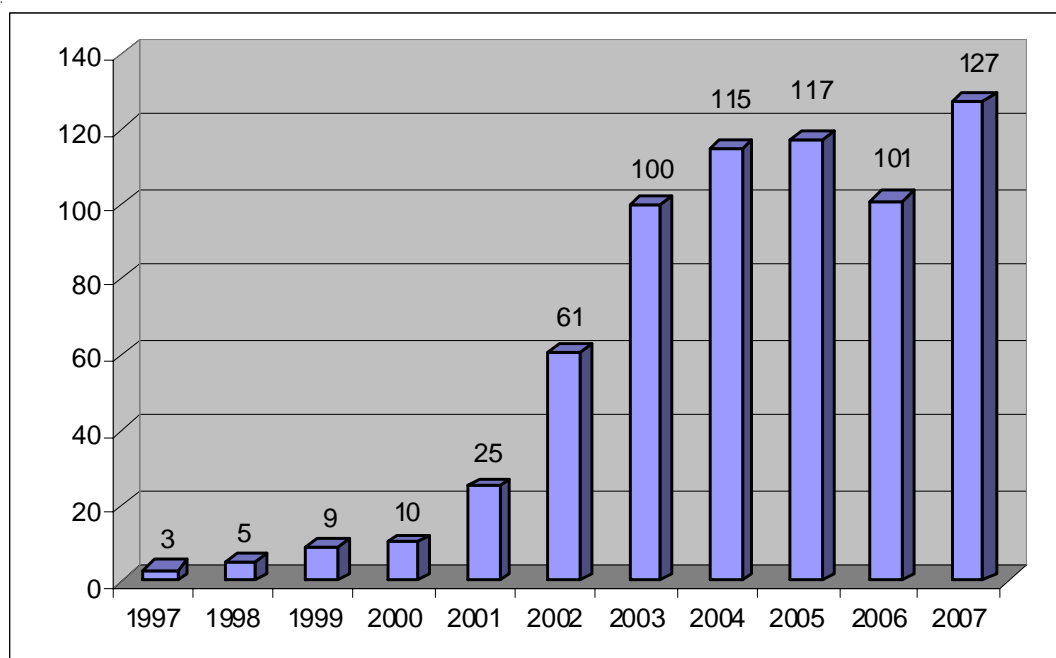
The titles and abstracts from the remaining 938 articles were read by both authors, and they were included just under opinion agreement. When the title made clear mention of the use of PDAs in healthcare (e.g. “All in the palm of your hand. Handheld computers in clinical practice”) or “Using PDAs during the internal medicine clerkship”), the article was retained. When there was uncertainty (as in the case of “Automating research data collection” or “Organizing literature information for clinical decision support”), then the abstract was read. If there was no clear reference to the use of PDAs in healthcare, then the selection was discarded from the list (exclusion criteria).

Another 265 articles were eliminated after this reading, leaving a final list of 673 articles on PDA usage in healthcare grouped by year of publication. Graph 1 illustrates this evolution.

It is important to note that in 2006, the number of articles published on PDAs in healthcare decreased from the previous year for the first time. This will be discussed later.

After this survey, there was a new review of titles and abstracts from the 673 articles included in this bibliographic compilation in order to classify them and group them by topic. To expedite the job of classifying articles, their bibliographic references (catalogued in “Reference Manager”) were exported to a text file and imported to an Access table. A small application was developed to allow for a quick view of the article and make classification easier. Figure 2 below shows the screen of this application.

The literature contains few proposals to classify articles on the use of PDAs in healthcare, as in the case of Kho, A (2006) – who divided articles researched in 6 groups (General attitudes; General uses; Formal



**Graph 1** – Number of articles on PDA use published annually

Figure 2 – Screen of application developed to classify articles from review

teaching, feedback, evaluation; Clinical teaching; Patient care, and Research use)<sup>(13)</sup>.

In this study, the articles selected were classified into the following five broad topics:

**Applications:** Articles classified under this topic dealt with experiences in the development and use of specific PDA applications (charts, medical accounts, medical calculators, menstrual cycle, visual acuity, transmission of medical data and images, prescriptions, etc.) in addition to articles that analyzed applications and contained a download site.

**Data Bases:** This area encompassed articles on medication data bases, guidelines, e-books, education, literature, and exercises for training and learning, in addition to other medical data bases available for PDAs.

**Data Collection:** Encompassed all articles that mentioned use of PDAs for collection of data for use in other systems. Examples include collection of data in the field, at the bedside, during home care, or from the patient's daily chart, in addition to research questionnaires.

**Review of Literature:** Involved articles that reviewed or recounted other publications on the topic, as well as those that made projections about PDA use in healthcare for coming years.

**Usability:** This category included introductory articles on the subject, articles on the potential and risks of this new technology, comparisons of tasks carried out with this equipment vs. the traditional manual method, studies of satisfaction in use and key barriers – in addition to items that addressed the ethical and

legal implications of PDA use.

Even with the absence of a specific methodology to guide such a classification, some criteria were used: - Worlds like “*database*”, “*guidelines*”, and “*knowledge*” found in abstracts were strong descriptors for classification in the Data Bases category.

- When the article evaluated a specific application that the authors developed, it was classified under Applications.

- If the article dealt with development of an application for collection of data to be processed by another computer, it was classified under **Data Collection** rather than **Applications**. If, on the other hand, the data collected were processed by the PDA itself, the item was classified under **Applications** rather than **Data Collection**.

- Finally, words such as “*literature*”, “*review*”, “*article*”, and “*future*” that were contained in the abstract were strong descriptors for classification under **Review of Literature**.

Like it was made before, when using inclusion criteria to select the articles, it was necessary that both authors were in accordance with the classification to maintain it.

## RESULTS

After the classification of 673 articles, the following result – presented in Graph 2 below – was obtained.

The largest quantity of articles published on the use of PDAs in the healthcare arena deal with existing or developed applications (270) and with evaluating the

potential and benefits derived from that technology (167), the vast majority of which present positive results.

When one ascertains evolution of the quantity of articles published using the proposed classification, one clearly notes a significant decrease in those that evaluate the usability of this equipment by healthcare professionals. At the same time, there was a significant increase in the number of articles dealing with applications by those same professionals.

It is possible that Graph 3 above reflects the fact that the use of PDAs by healthcare professionals is being treated in a very natural fashion in light of the successful experiences already recounted – something that weakens, or at least diminishes, the impact in articles of that nature. That same graph shows a tendency toward a demand for and development of better applications for these professionals to use in their PDAs.

One can also ascertain that there was always space for publishing of experiences regarding the use of

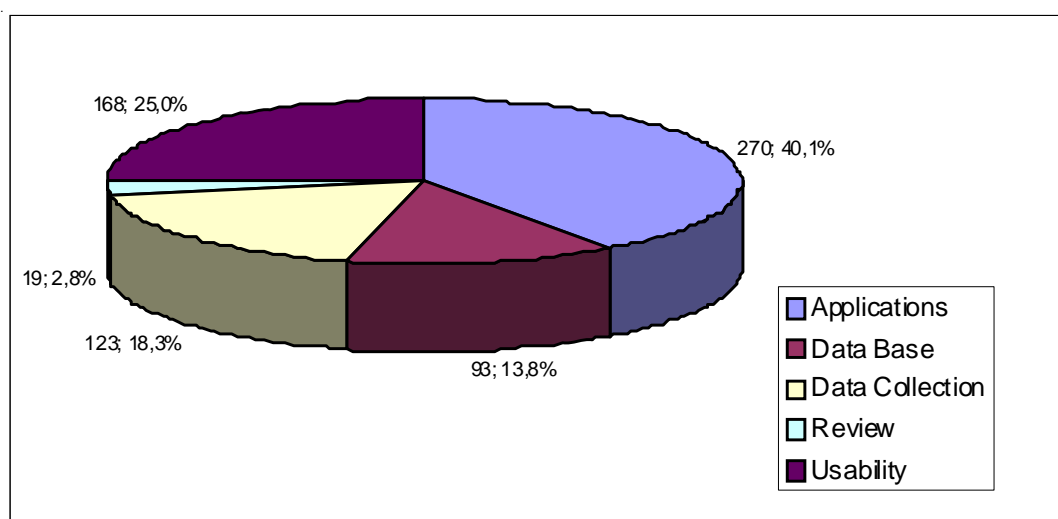
PDAs for collecting data, while reporting on the use of PDAs to access knowledge bases (medications, CID, guidelines, etc.) only begins to appear as of 2001, with the first bibliographic reviews coming out in 2002.

## DISCUSSION

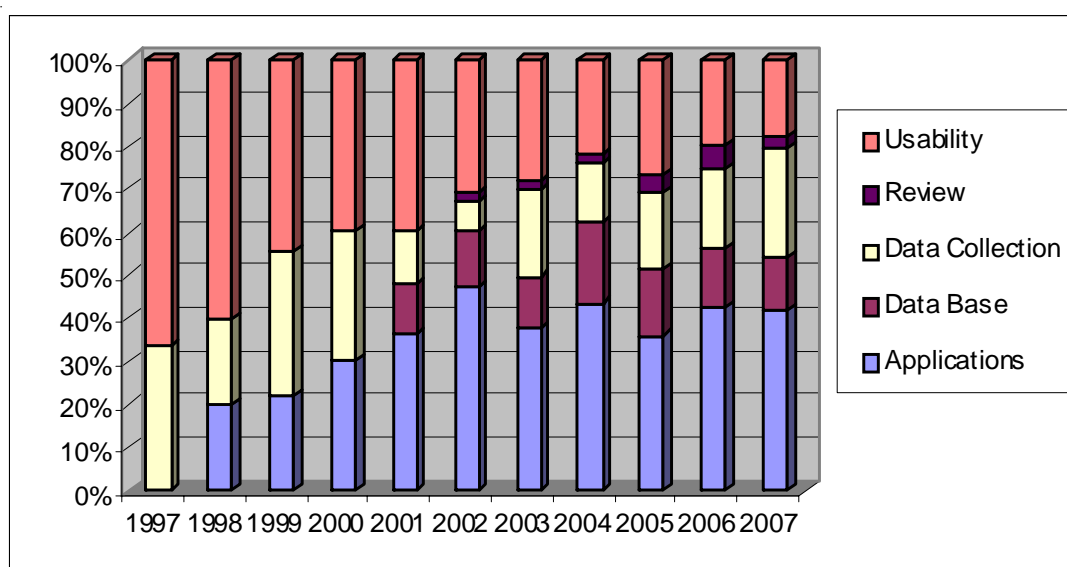
There was a small drop in scientific production regarding the use of PDAs in the healthcare field in 2006; still, this may have been a discrete event. New surveys are needed in coming years with the same criteria set forth in this study to confirm that hypothesis.

If, on the one hand, the number of publications on PDA usability in healthcare decreases, new space is created for publications on applications already being used. It is possible that the advantages of PDA use had already become clear in articles from previous years and no longer lack arguments.

There are, of course, other ways to group or categorize these publications. One different way would be to separate them by specific healthcare topic like



Graph 2 – Classification of articles on PDAs published between 1997 and 2007



Graph 3 – Publications on PDAs, by areas of classification, between 1997 and 2006

Holubar (2007), who only reviewed articles on medical nutrition and the applications available for that specialty<sup>(14)</sup>.

## CONCLUSION

The use of PDAs by healthcare professionals has grown considerably over the past few years. Several authors have recounted positive experiences using this equipment when compared to the traditional logging of information on paper, or when there is a need to access knowledge bases<sup>(15)</sup>.

The number of articles published on the use of these devices by professionals or students has continued to increase since 1996, which suggests continued interest in and relevance of this topic.

As for the classification of the 673 articles by topic addressed, it was possible to determine that 270 of them (40.1%) dealt with the development or use of specific applications, 168 (25.0%) evaluated user behavior vis-à-vis usability (including positive and/or

negative factors associated with usage), 123 (18.3%) recounted experiences in the use of handhelds for data collection (in these cases, these same data were in general handled by another application resident in the desktop or web server), 93 articles (13.8%) mention the use of PDAs to consult knowledge base (pharmacopedia, e-books, guidelines, etc), and only 19 (2.8%) performed a systematic review of articles already published.

It is important to underscore that the number of articles focusing on the usability of handhelds and related systems has been steadily decreasing and giving way to articles recounting the development and use of specific applications. This is the first study in the literature that points to this trend. On the other hand, one can clearly see that the adoption of these devices for data collection was always a topic of articles throughout the past decade.

New reviews can be produced periodically in order to confirm these trends or identify any change(s) in course by scientific publications on handhelds in the healthcare field.

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